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Molybdenum

UNITED STATES DEPARTMENT OF THE INTERIOR

The statistical data in this volume represents the most comprehensive, verified, domestic and international coverage for 1987 at the time the volume went to press. More recent information can be found in the monthly Molybdenum Mineral Industry Surveys obtainable from Publications Distribution, Bureau of Mines, Box 18070, Cochrans Mill Road, Pittsburgh, PA 15236.

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UNITED STATES DEPARTMENT OF THE INTERIOR • Donald Paul Hodel, Secretary

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This publication is a chapter from the current Bureau of Mines Minerals Yearbook, comprising *Volume I, Metals and Minerals; Volume II, Area Reports: Domestic; Volume III, Area Reports: International.* The separate volumes of the Yearbook are sold by the Superintendent of Documents, Washington, D.C. 20402.

Molybdenum

By John W. Blossom[1]

Domestic and foreign molybdenum markets increased in 1987 and demand in market economy countries exceeded mine production. Domestic producer and consumer stocks increased in 1987. U.S. mine output of molybdenum decreased compared with that of 1986 and represented 40% of the world production. Reported end-use consumption of molybdenum in raw materials and apparent domestic demand increased compared with that of 1986. Exports of all forms of molybdenum from the United States decreased during 1987. Domestic producers' stocks of molybdenum increased, but confronted with stock inventories equivalent to about 1-1/3 years' consumption, domestic producers' prices were weak. World market prices were below those of U.S. producer quoted price listings for 1987.

Domestic Data Coverage.—Domestic production data for molybdenum are developed by the Bureau of Mines by means of three separate, voluntary surveys. These surveys are "Molybdenum Ore and Concentrate," "Molybdenum Concentrate and Molybdenum Products," and "Molybdenum Concentrates." Out of 18 operations to which surveys were sent, all responded, representing 100% of the total production shown in table 1.

Table 1.—Salient molybdenum statistics

(Thousand pounds of contained molybdenum and thousand dollars)

	1983	1984	1985	1986	1987
United States:					
Concentrate:					
Production	33,593	101,661	108,409	93,976	75,117
Shipments	48,805	102,405	111,936	95,006	69,868
Value	$166,612	$826,780	$347,812	$240,484	$179,286
Reported consumption	27,014	54,843	W	53,061	37,442
Imports for consumption	1,673	28	112	1,120	1,264
Stocks, Dec. 31: Mine and plant	11,627	12,459	9,922	8,715	15,092
Primary products:					
Production	37,333	79,669	87,436	81,490	34,659
Shipments	50,562	65,527	73,861	57,855	40,668
Reported consumption	27,227	51,792	33,451	31,808	32,629
Stocks, Dec. 31: Producers	28,852	22,155	21,014	20,609	22,168
World: Mine production	r140,616	r214,275	216,364	p203,466	e186,465

eEstimated. pPreliminary. rRevised. W Withheld to avoid disclosing company proprietary data.

DOMESTIC PRODUCTION

Domestic mine production of molybdenum decreased to a total of 75 million pounds of contained molybdenum, compared with 94 million pounds in 1986. The country's two largest producers were AMAX Inc. and Cyprus Minerals Co. Domestic producers attempted to correct oversupply by reducing production.

Table 2.—Production, shipments, and stocks of molybdenum products in the United States

(Thousand pounds of contained molybdenum)

	1986	1987	1986	1987	1986	1987
	Molybdic oxides[1]		Metal powder		Ammonium molybdate	
Received from other producers	37,224	22,801		W	W	1,621
Gross production during year	25,445	W	5,382	5,925	W	W
Used to make other products listed here	19,298	18,706	1,126	1,744	1,749	1,771
Net production	6,147	W	4,256	4,181	W	W
Shipments	43,347	W	4,208	4,333	W	W
Producer stocks, Dec. 31	16,459	W	W	457	W	W
	Sodium molybdate		Other[2]		Total	
Received from other producers	W	W	2,378	218	39,602	24,640
Gross production during year	W	W	10,663	28,734	41,490	34,659
Used to make other products listed here	W	W	1,363	1,181	23,536	23,402
Net production	W	W	7,550	7,076	17,953	11,257
Shipments	W	W	10,300	36,335	57,855	40,668
Producer stocks, Dec. 31	W	W	4,240	21,711	20,699	22,168

W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes technical and purified molybdic oxide and briquets.

[2]Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, molybdenum disulfide, molybdic acid, molybdenum metal, pellets, molybdenum pentachloride, molybdenum hexacarbonyl, and data indicated by symbol W.

CONSUMPTION AND USES

The quantity of molybdenum in concentrate roasted domestically to produce technical-grade molybdic oxide decreased from that of 1986. The remainder of the mine production of concentrate was either exported for conversion, purified to lubrication-grade molybdenum disulfide, or added to the stocks at mines and plants. The oxide, or roasted concentrate, is the chief form of molybdenum utilized by industry, particularly steel, cast iron, and superalloy producers. However, some of the material is also converted to other molybdenum products, such as ferromolybdenum, high-purity oxide, ammonium and sodium molybdate, and metal powder.

Apparent consumption (defined as U.S. primary plus secondary production plus imports minus exports plus adjustments for Government and industry stock changes) decreased to 33 million pounds of molybdenum. The total reported end-use consumption of molybdenum in raw materials increased about 2% from that of 1986. Molybdenum consumed in oxide form (technical-grade, purified, and briquets) accounted for about 58% of total reported consumption; in ferromolybdenum, 16%; and in other forms, 26%.

Molybdenum reported as consumed in the production of steel accounted for 56% of total consumption. Approximately 15% of consumption was attributed to other metallurgical uses, such as cast irons, superalloys, and as a refractory metal. Catalyst, lubricant, pigment, and other nonmetallurgical applications composed the final 29% of total consumption.

Table 3.—U.S. reported consumption of molybdenum, by end use

(Thousand pounds of contained molybdenum)

End use	Molybdic oxides	Ferromolybdenum[1]	Ammonium and sodium molybdate	Other molybdenum materials[2]	Total[3]
1986					
Steel:					
Carbon	792	79			871
Stainless and heat resisting	4,300	531		121	4,952
Full alloy	6,532	813		69	7,414
High-strength, low-alloy	633	720		W	1,383
Tool	1,688	W		W	1,688
Cast irons	W	909		W	909
Superalloys	998	109		1,572	2,679
Alloys (excludes steels and superalloys):					
Welding and alloy hard-facing rods and materials		202		7	209
Other alloys[4]	229	114		133	476
Mill products made from metal powder				4,296	4,296
Chemicals and ceramics:					
Pigments	W		W		W
Catalysts	2,882		W	W	2,882
Other	9	2		766	777
Miscellaneous and unspecified	453	615	1,761	533	3,362
Total	18,546	4,094	1,761	7,497	31,898
1987					
Steel:					
Carbon	926	263		(5)	1,189
Stainless and heat resisting	5,604	504		148	6,257
Full alloy	6,454	1,198		59	7,712
High-strength, low-alloy	726	762		4	1,492
Tool	1,568	W		49	1,617
Cast irons	W	1,275		20	1,295
Superalloys	1,113	99		1,664	2,876
Alloys (excludes steels and superalloys):					
Welding and alloy hard-facing rods and materials		216		12	228
Other alloys[4]	217	120		120	456
Mill products made from metal powder				3,752	3,752
Chemicals and ceramics:					
Pigments	W		W		W
Catalysts	1,794		W	365	2,159
Other	8		1	729	737
Miscellaneous and unspecified	536	621	1,821	81	2,859
Total[3]	18,945	5,059	1,822	7,003	32,829

W Withheld to avoid disclosing company proprietary data.
[1]Includes calcium molybdate.
[2]Includes purified molybdenum disulfide, molybdenite concentrate added directly to steel, molybdenum metal powder, molybdenum metal, pellets, and other molybdenum materials.
[3]Data may not add to totals shown because of independent rounding.
[4]Includes magnetic and nonferrous alloys.
[5]Less than 1/2 unit.

STOCKS

Total industry stocks, which include those of producers and consumers, increased to 43 million pounds of contained molybdenum. Inventories of molybdenum in concentrate at mine locations increased from 8.7 to 15.1 million pounds. Producers' stocks of molybdenum in consumer products, such as oxide, ferromolybdenum, molybdate, metal powders, and other types, increased to 22 million in 1987. Compared with apparent consumption, yearend producers' stocks of these materials totaled about 1-1/3 years' supply. Domestic consumers held inventories of about 6 million pounds throughout most of the year, representing approximately a 2-month supply compared with average monthly reported consumption.

Table 4.—Industry stocks of molybdenum materials, December 31

(Thousand pounds of contained molybdenum)

Material	1983	1984	1985	1986	1987
Concentrate: Mine and plant	11,697	12,450	9,322	8,715	15,662
Producers:					
Molybdic oxides[1]	22,991	17,295	16,281	16,459	W
Metal powder	340	594	W	W	457
Ammonium molybdate	1,938	694	W	W	W
Sodium molybdate	79	W	W	W	W
Other[2]	3,741	3,582	4,733	4,250	21,711
Total	29,352	22,155	21,014	20,709	22,168
Consumers:					
Molybdic oxides[1]	1,467	1,552	2,020	2,168	3,603
Ferromolybdenum[3]	379	721	597	618	574
Ammonium and sodium molybdate	79	80	47	129	76
Other[4]	1,567	1,540	1,778	1,654	1,643
Total[5]	3,674	3,993	4,441	4,569	5,925
Grand total[5]	43,663	38,498	34,777	33,983	43,175

W Withheld to avoid disclosing company proprietary data.

[1]Includes technical and purified molybdic oxide and briquets.

[2]Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, molybdenum disulfide, molybdic acid, molybdenum metal, pellets, molybdenum pentachloride, and molybdenum hexacarbonyl.

[3]Includes calcium molybdate.

[4]Includes purified molybdenum disulfide, molybdenite concentrate added directly to steel, molybdenum metal powder, molybdenum metal, pellets, and other molybdenum materials.

[5]Data may not add to totals shown because of independent rounding.

PRICES

The price of "Metals Week Dealer" (MWD) molybdic oxide (per pound of contained molybdenum) decreased from $3.18 in January to $2.85 at the end of December 1987. The average MWD price of oxide was $3.01 or $0.10 less than the average MWD price in 1986.

The posted producer price for molybdic oxide was $3.45 in January. During May the price was reduced to $3.25 and remained at that level through December 1987.

Table 5.—Domestic price listings for molybdenum

(Per pound of contained metal)

	1986	1987
Merchant quotes:		
Concentrate (byproducts)	$2.50	$2.50
Ferromolybdenum-export	3.52	3.56
Oxide	2.92	3.01
Producer quotes: Oxide	3.45	$3.45-3.25

Source: Metals Week.

FOREIGN TRADE

Exports.—Exports of molybdenum in concentrate and oxide decreased compared with that of 1986. Molybdenum concentrate exports were about 54% of domestic mine production. Approximately 98% of reported concentrates and oxides was shipped to Austria, Belgium-Luxembourg, Canada, the Federal Republic of Germany, Japan, the Netherlands, Sweden, and the United Kingdom. The calculated molybdenum content of all exports was 46 million pounds in 1987. Total value of exports decreased from $185 million in 1986 to $140 million in 1987.

Imports.—Approximately 13.5 million pounds of molybdenum in various forms was imported into the United States, an increase of 7.5 million pounds over that of 1986. Total value of all forms of molybdenum imported increased from $27 million in 1986 to $48 million in 1987. In terms of both value and quantity, the major forms imported were as concentrate, materials in chief value molybdenum, and molybdenum compounds. The principal originating countries for these imports were Canada and Chile.

The President withdrew the duty-free

treatment afforded under the Generalized System of Preferences (GSP) to imports of molybdenum ore, TSUS-601.33, and materials in chief value of molybdenum, TSUS-603.40, from all countries on or after December 31, 1987. In addition, the President issued Proclamation 5758 on December 24, 1987, which stated that general headnote 3 (e)(v)(A) to the TSUS is modified by striking out "Chile" from the enumeration of independent countries whose products are eligible for benefits under the GSP; and that no article that is the product of Chile and imported into the United States after the effective date of this Proclamation shall be eligible for preferential treatment under the GSP. This Proclamation was to become effective on February 29, 1988.

The countries mostly affected by these changes were Chile, Mexico, and Peru.

Table 6.—Molybdenum reported by producers as shipments for export from the United States

(Thousand pounds of contained molybdenum)

	1986	1987
Molybdenite concentrate	18,207	21,198
Molybdic oxide	21,025	12,273
All other primary products	836	966

Table 7.—U.S. exports of molybdenum ore and concentrates (including roasted concentrates), by country

(Thousand pounds of contained molybdenum and thousand dollars)

Country	1985		1986		1987	
	Quantity	Value	Quantity	Value	Quantity	Value
Austria	11	50			4,969	11,576
Belgium-Luxembourg	5,741	30,114	3,986	8,782	5,937	12,526
Brazil	150	627	222	761	114	581
Canada	780	1,979	3,682	8,149	1,597	2,348
Chile	102	377	93	139	44	169
France					228	644
Germany, Federal Republic of	3,979	7,756	2,028	4,289	5,966	13,564
Japan	7,031	26,202	5,818	16,555	2,852	8,071
Mexico	71	135	22	107	9	18
Netherlands	40,076	160,250	24,997	75,802	12,443	31,557
Sweden	949	2,896	2,792	6,047	1,275	3,002
United Kingdom	4,991	15,463	6,233	13,499	5,765	12,911
Other	552	1,840	188	845	611	1,615
Total[1]	65,859	247,690	49,150	136,086	40,514	98,381

[1]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

Table 8.—U.S. exports of molybdenum products, by product and country

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1986		1987	
	Quantity	Value	Quantity	Value
Ferromolybdenum: [1]				
Canada	49	154	45	171
Japan	187	496	74	314
Malaysia	1	4	4	15
Mexico	101	346	27	74
Other	5	19	11	31
Total[2]	332	929	161	605
Metal and alloys in crude form and scrap:				
Belgium	1	17	1	4
Canada	54	317	22	184
France	2	34	8	36
Germany, Federal Republic of	148	790	70	418
India	2	9	1	6
Japan	220	923	227	1,406
Mexico	9	105	12	128
Netherlands	139	171	78	323
United Kingdom	344	592	16	154
Other	101	153	78	845
Total[2]	1,000	3,111	513	3,504

See footnotes at end of table.

Table 8.—U.S. exports of molybdenum products, by product and country —Continued

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1986		1987	
	Quantity	Value	Quantity	Value
Wire:				
Argentina	3	76	2	41
Belgium-Luxembourg	8	349	20	257
Brazil	42	750	47	803
Canada	46	760	31	530
France	14	199	23	403
Germany, Federal Republic of	97	1,086	202	2,506
India	[3]	8	[3]	6
Italy	66	886	67	975
Japan	86	1,989	67	1,260
Mexico	19	107	9	252
Netherlands	2	23	4	32
Singapore	6	51	2	53
South Africa, Republic of	[3]	9	2	28
Spain	19	234	19	257
Sweden	22	277	25	382
United Kingdom	26	471	15	349
Other	28	386	39	907
Total[2]	494	7,671	573	9,043
Powder:				
Belgium-Luxembourg	71	485	974	2,363
Canada	14	175	289	2,576
France	64	357	92	589
Germany, Federal Republic of	16	195	77	379
Italy	5	60	2	31
Japan	210	278	7	88
Mexico	1	6	6	44
Netherlands	333	330	26	181
Sweden	7	51	13	92
Taiwan	49	437	133	944
United Kingdom	45	91	497	1,156
Other	41	356	28	423
Total[2]	854	2,821	2,145	8,866
Semifabricated forms, n.e.c.:				
Australia	11	216	8	149
Belgium-Luxembourg	3	148		
Brazil	45	855	19	343
Canada	20	571	13	324
France	31	914	34	1,146
Germany, Federal Republic of	83	1,497	29	655
Japan	7	223	29	704
Mexico	[3]	14	3	76
Netherlands	34	1,145	63	2,547
Philippines			[3]	2
Singapore	[3]	2	[3]	5
South Africa, Republic of	10	385	7	291
United Kingdom	75	1,752	47	1,287
Other	167	1,398	30	938
Total[2]	486	9,119	282	8,167
Molybdenum compounds:				
Argentina			[3]	2
Australia	1	3	8	16
Belgium-Luxembourg	546	824	68	342
Brazil	11	40	5	21
Canada	138	411	274	1,160
Germany, Federal Republic of	3,234	4,219	3	31
Japan	1,880	4,027	3,152	7,240
Mexico	60	129	86	220
Netherlands	3,262	4,532	159	335
Sweden	1,879	2,450		
Switzerland	[3]	2		
United Kingdom	4,347	5,479	159	373
Other	1,703	2,882	791	1,407
Total[2]	17,063	24,997	2,696	11,146

[1]Ferromolybdenum contains about 60% to 65% molybdenum.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/2 unit.

Source: Bureau of the Census.

Table 9.—U.S. imports for consumption of molybdenum

(Thousand pounds and thousand dollars)

Item	TSUS No.	1986			1987		
		Gross weight	Contained molybdenum	Value	Gross weight	Contained molybdenum	Value
Ore and concentrate	601.33	1,740	1,120	3,057	2,195	1,264	3,109
Material in chief value molybdenum	603.40	1,786	1,102	3,284	8,664	5,248	15,497
Ferromolybdenum	606.31	1,590	1,077	3,626	3,815	2,283	8,042
Waste and scrap	628.70	NA	529	2,870	NA	646	2,545
Unwrought	628.72	NA	191	2,510	NA	174	2,308
Wrought	628.74	102	NA	2,701	158	NA	2,801
Ammonium molybdate	417.28	528	318	1,320	1,355	786	2,870
Molybdenum compounds	419.60	1,870	1,236	4,913	2,702	1,822	7,594
Potassium molybdate	420.20	40	27	134			
Sodium molybdate	421.10	434	403	758	150	64	262
Mixtures of inorganic compounds, chief value molybdenum	423.88	127	38	212	66	46	220
Molybdenum orange	473.18	1,651	NA	1,754	2,438	NA	2,461
Total[1]		9,878	6,040	27,138	21,543	12,333	47,711

NA Not available.

[1]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

Table 10.—U.S. import duties on molybdenum

Item	TSUS No.	Most favored nation (MFN)	Non-MFN
		Jan. 1, 1987	Jan. 1, 1987
Molybdenum ore and concentrate	601.33	9 cents per pound	35 cents per pound.
Material in chief value molybdenum	603.40	6 cents per pound plus 1.9% ad valorem.	50 cents per pound plus 15% ad valorem.
Ferromolybdenum	606.31	4.5% ad valorem	31.5% ad valorem.
Molybdenum:			
Waste and scrap	628.70	6% ad valorem	50% ad valorem.
Unwrought	628.72	6.3 cents per pound plus 1.9% ad valorem.	50 cents per pound plus 15% ad valorem.
Wrought	628.74	6.6% ad valorem	60% ad valorem.
Molybdenum chemicals:			
Ammonium molybdate	417.28	4.3% ad valorem	29% ad valorem.
Calcium molybdate	418.26	Free	24.5% ad valorem.
Molybdenum compounds	419.60	3.2% ad valorem	20.5% ad valorem.
Potassium molybdate	420.22	3% ad valorem	23% ad valorem.
Sodium molybdate	421.10	3.7% ad valorem	25.5% ad valorem.
Mixtures of inorganic compounds, chief value molybdenum	423.88	2.8% ad valorem	18% ad valorem.
Molybdenum orange	473.18	3.9% ad valorem	25% ad valorem.

WORLD REVIEW

World mine production of molybdenum was 187 million pounds, a decrease of 17 million pounds from that in 1986. Canada, Chile, the U.S.S.R., and the United States accounted for more than 87% of the molybdenum produced worldwide. Although comprehensive statistics on world consumption were not available, market evidence clearly indicated that supply exceeded demand. World molybdenum consumption and stocks increased during 1987.

[1]Physical scientist, Branch of Ferrous Metals.

Table 11.—Molybdenum: World mine production, by country[1]

(Thousand pounds of contained molybdenum)

Country[2]	1983	1984	1985	1986[p]	1987[e]
Bulgaria[e]	420	420	420	400	400
Canada (shipments)	22,474	25,479	17,311	24,804	25,520
Chile	33,651	37,172	40,541	36,555	36,600
China[e]	4,400	4,400	4,400	4,400	4,400
Japan[e]	214	324	215		
Korea, Republic of	313	348	734	696	700
Mexico	12,932	8,936	8,292	7,285	8,000
Mongolia[e]	2,150	2,200	2,200	[r]2,425	2,425
Niger[e]	88	73	44	44	55
Peru	5,925	6,557	8,959	7,681	7,700
Philippines	86				
U.S.S.R.[e]	24,500	24,700	24,900	25,100	25,300
United States	35,593	102,664	108,499	93,976	[p]75,117
Total	140,616	214,275	216,364	203,566	186,400

[e]Estimated [p]Preliminary [r]Revised

[1]Table includes data available through June 17, 1988.

[2]In addition to the countries listed, North Korea, Romania, Turkey, and Yugoslavia are believed to produce molybdenum, but output is not reported quantitatively, and available general information is inadequate to make reliable estimates of output levels.

[3]Reported figure.

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